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Appendix E

Table 12.3 Molecular Weights, Boiling Points, and Solubilities of Some Simple Alkanes, Alcohols, and Ethers

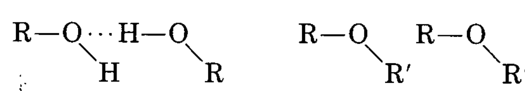
Name	Structural Formula	MW	BP (°C)	Solubility in Water
Ethane	$CH_3—CH_3$	30	−88	Insoluble
Methanol	$CH_3—OH$	32	65	Soluble
Propane	$CH_3—CH_2—CH_3$	44	−42	Insoluble
Dimethyl ether	$CH_3—O—CH_3$	46	−23	Soluble
Ethanol	$CH_3—CH_2—OH$	46	78	Soluble
Butane	$CH_3—CH_2—CH_2—CH_3$	58	0	Insoluble
Ethyl methyl ether	$CH_3—CH_2—O—CH_3$	60	11	Soluble
1-Propanol	$CH_3—CH_2—CH_2—OH$	60	97	Soluble
Ethylene glycol	$HO—CH_2—CH_2—OH$	62	198	Soluble
Pentane	$CH_3—CH_2—CH_2—CH_2—CH_3$	72	36	Insoluble
Diethyl ether	$CH_3—CH_2—O—CH_2—CH_3$	74	35	Slightly soluble
Methyl propyl ether	$CH_3—CH_2—CH_2—O—CH_3$	74	39	Slightly soluble
1-Butanol	$CH_3—CH_2—CH_2—CH_2—OH$	74	117	Slightly soluble
1,3-Propanediol	$HO—CH_2—CH_2—CH_2—OH$	76	214	Soluble

Boiling Point

Ethers have about the same boiling points as alkanes of similar molecular weight. Thus, with respect to boiling points, ethers are essentially no different from hydrocarbons or halides.

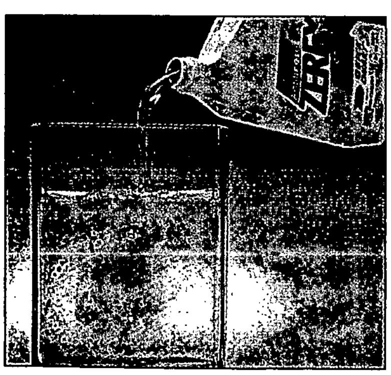
This is not true for alcohols. The boiling points of alcohols are much higher than those of the corresponding alkane and ether, and those of the diols are much higher still. This is easily explained by hydrogen bonding. Each alcohol molecule can form a hydrogen bond with another one, but an ether molecule cannot:

Review Section 6.6 for a discussion of which molecules can form hydrogen bonds.



Alcohol Alcohol Ether Ether
(no hydrogen bond possible)

Alcohols have higher boiling points because hydrogen bonds must be broken during boiling, and this requires energy, available only at higher temperatures. Diols, with two —OH groups, have hydrogen bonds on two sides, so their boiling points are higher still. Hydrogen bonding also accounts for the viscosity of such liquids as ethylene glycol and glycerol.



Hydrogen bonding accounts for ethylene glycol's viscosity and its solubility in water. (Photograph by Charles D. Winters.)

Solubility in Water

A look at Table 12.3 shows that both alcohols *and* ethers are soluble in water, up to about three or four carbons. This behavior is, of course, completely different from that of the hydrocarbons and halides. Again, the